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SCALING OF MEASURED VELOCITY SPECTRA FROM THE 168 METER TALL MET-TOWER AT HøVSøRE, DENMARK:

EVIDENCE OF COMBINED INERTIAL K^{-5/3} AND PRODUCTION K⁻¹ SUBRANGES IN THE NEAR-NEUTRAL ATMOSPHERIC SURFACE LAYER

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Today's ~ 5 MWatt turbines operate in the part of the spectrum that is generated by wind shear.

In shear driven turbulence, the shear stress velocity u_* becomes an appropriate scaling parameter and dimensional analysis for the wind spectrum leads to the prediction of a so-called "production subrange" u_*²k⁻¹.
We present spectral measurements from seven sonic anemometers mounted in the up to 168 m tall Høvsøre test Station met-towers.

Based on these observations the classical Inertial subrange spectrum is extended with a "production subrange"

Wind turbines operate in the surface-layer.

In a spectral sense, surface layer turbulence at hub height is generated by wind shear on scales comparable to the hub height, then cascading through the Inertial subrange before dissipating.

For the past generations of wind turbines, towers were relatively tall compared to the rotor diameters; and it has been a good approximation to assume that the turbines operated entirely within the inertial subrange turbulence characterized by a k^{-5/3} spectrum, where k is the wave number.

However, on today's huge 2 to 5 MWatt turbines the rotor diameters have become significantly bigger than the hub height, in particular so for turbines operation in offshore wind farms, and so they partly operate closer to the surface, relative to the hub height.

The turbines therefore now operate in the part of the spectrum that is generated by shear: In shear driven turbulence, the constant stress velocity u_* becomes the appropriate scaling parameter at wave numbers smaller than 2π/H;, where H is the measurement height (turbine's hub height). For such wave numbers dimensional analysis leads to a so-called "production subrange" of the form:u_*²k⁻¹ as originally predicted by Tchen (1951) .

We present spectral measurements from seven sonic anemometers mounted in the up to 168 m tall Høvsøre test Station met-towers.

The classical Kaimal spectrum is extended with a "production subrange" for scales kH <1, where H is the height above the ground and parameterised in terms of surface layer scaling parameters.

The measured spectra are compared with a model that combines both the inertial and production subrange theory.